IDEA Commons

Recommendations from GIVE™ Workshop: LEED® Analysis and Energy Modeling

Final Report

January 22, 2010

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Table of Contents

FINAL REPORT

LEED Analysis and Green Development Recommendations and Workshop Documentation

January 22, 2010

Figure 1: Adaptive Reuse of the Willow Brook Foods Processing Facility

Executive Summary

This report is intended to provide design recommendations for the new Entrepreneurial and Business Development Center (EBDC) located at Missouri State University (MSU) in Springfield, Missouri. The EBDC project involves the renovation and adaptive reuse of a former 120,000-square foot processing facility. The EBDC project is part of the IDEA Commons initiative proposed by MSU and the City of Springfield, which has a goal to create a vibrant, urban community and research park in an urban setting that blends residential, retail, commercial, and entertainment areas.

The EBDC project has the potential to be a demonstration model for MSU in cost-effective energy and environmental features. Given its existing conditions and proposed program, the most promising of these features are described in the report with references and recommendations for design and construction including:

1. Increase roof insulation
2. Daylighting

3. Cool Roof
4. Energy Management Systems (EMS)
5. Innovations in HVAC systems design
6. Green materials
7. Green infrastructure, including porous paving and structural soil cells ("Urban Oasis")

On December 2, 2009, a Green Initiative Value Engineering (GIVE™) Workshop was orchestrated by Vita Nuova LLC with MSU staff, City of Springfield staff, and the architecture and engineering team. This workshop focused on green design strategies for the EBDC project. The goals of the December workshop were to:

1. Review program documentation to date for new MSU facilities on the former Willow Brook Foods property at 405 N. Jefferson Street, Springfield Missouri.
2. Provide a conceptual framework for the site and buildings that represents "green values," and that follows Leadership in Energy and Environmental Design (LEED) rating and other cost-effective approaches for sustainable development.
3. Document the workshop discussion for a follow-up report in order to provide a record of discussion and include Vita Nuova consultant recommendations.

It was found that the project, with some attention to these features, could qualify for LEED Silver rating under the LEED 2009 New Construction and Major Renovations Rating System, with the LEED Gold rating as a feasible goal. This project is unique not only for the region but nationally, and LEED certification would further the ambitious business development, research and academic goals of the project.

Using a comparative energy model, it was found that there was a potential for a 39% total annual energy savings for a 100,000-square foot office building in Springfield when compared to a building with "typical construction" and a low-energy design case. The most cost-effective low-energy design strategies were energy efficient lights, minimizing duct leakages and improving insulation. Improving roof insulation (R-38) could have a 6.2% reduction in the total annual energy costs when compared to typical construction. An 8.3% reduction in the total annual energy costs when compared to typical construction was possible when using R-55 insulation.

Figure 2: Map of IDEA Commons Campus

Final Recommendations

Green Development Approaches to Building

The discussion in this section provides more detail than was possible during the GIVE™ Workshop; it outlines a set of recommended approaches to the green design of the building and site.

The roof repair and replacement is required immediately and will be designed and contracted as a first step of construction prior to completion of design of other elements. The new roof will be installed in four to six months. Specifications for the new roof are a top priority.

The roof replacement allows consideration of three significant energy-efficient measures:

- Increased roof insulation
- Daylighting
- Cool roof

Increased Roof Insulation
Increasing roof insulation above what is required by code should be considered in order to downsize the size and energy requirements of heating, ventilation and air conditioning (HVAC) equipment. The determination of what amount of insulation would enable a "step-down" to smaller HVAC requirements is made possible with energy modeling, which compares alternatives (i.e., energy requirements of code compliant design, compared to various levels of increased insulation). A simple energy model would be valuable to show the ideal amount of insulation, over and above the code minimum.

Daylighting
Installation of skylights can provide natural lighting sufficient to replace electric lighting that is normally used for "ambient lighting" of interior spaces. Skylighting (and side lighting where feasible) should be considered to provide high levels of natural lighting for stairways, corridors and destinations. Skylighting can also provide highly efficient lighting for high space work areas. Diffuse natural lighting is considered superior to artificial lighting in factory floor areas where visual acuity is required.

As a rule of thumb, 2% of the roof area assigned to skylights can achieve effective daylighting, sufficient to eliminate the need for electric light during daylight hours. Small skylights (2-3 square feet) can be spaced to provide general area lighting sufficient to replace the requirement for electric lighting, except for task lighting, which should be at the desk level and allow flexible location and adjustment.

Skylights can be placed to provide ambient lighting sufficient to meet lighting requirements during daylight hours. In addition, there are post-occupancy reports of productivity, health and safety benefits. The use of daylighting in factories improves acuity of lighting, due to its ambient and multidirectional incidence. Daylighting works best in high ceiling spaces and, in many applications, allows the elimination of a "hung ceiling" (which can reduce costs). Careful study of lighting (in schematic design phases) will result in further cost reduction opportunities by careful (and minimal) allocation of lighting fixtures to reduce and eliminate unnecessary lighting fixtures.

Daylighting design should be combined with energy efficient lighting. In day lit areas, electric lighting should have automatic sensors that follow available light levels. Lighting controls (automatic and zoned for use) can reduce lighting costs in the range of 50% to 75% for typical commercial applications. A photometric control of lights is recommended where skylights or clerestories provide daylighting. Studies by Lawrence Berkeley Laboratory and others document that daylighting can realize a return on investment within five to seven years, subject to application. (See Daylighting - Whole Building Design Guide, November 2008, Technologies Division, Lawrence Berkeley National Laboratory, http://www.wbdg.org/resources/daylighting.php)

Cool Roof
A cool roof consists of materials that reflect the sun's heat from the roof surface. Cool materials for low-slope roofs are mainly bright white in color. Cool roofs must also have high emissivity, allowing them to emit infrared energy. Cool roofs can reduce the roof surface temperature by up

to 100°F, thereby reducing the heat transferred into the building below. This helps to reduce energy costs, improve occupant comfort, cut maintenance costs, increase the life cycle of the roof, and reduce urban heat island effects. Cool roofs can reduce annual air conditioning consumption by 10% to 40%, depending on location, building design and climate.

A light-reflective roofing surface reduces the heat buildup and reduces summer peak load air-conditioning requirements. If clerestory lighting is utilized, a white reflective roof increases reflected daylight. Benefits include reduced air-conditioning; air conditioning units run less, which reduces wear and maintenance on the units. (See Design Cost Data, http://www.dcd.com/insights/novdec_2005_9.html)

A white ethylene propylene diene terpolymer (EPDM) rubber roof provides one form of cool roof (see Figure 3: Comparison of White vs. Dark Roof Surfaces and Resulting Temperatures). The MSU Facilities Department stated that it is not satisfied with constructed results of this product and therefore does not allow this material to be used on MSU buildings. Successful installation requires exacting requirements for use and supervision of installation of moisture and temperature control at the building site. Given the dramatic advantages that are achieved with "cool roof" applications, it is recommended that this prohibition be revisited and some form of cool roof application be used.

Cool roof specification and methods of installation are now established through the widely accepted industry standards of the Cool Roof Rating Council. (See http://www.coolroofs.org/)

Figure 3: Comparison of White vs. Dark Roof Surfaces and Resulting Temperatures

(Photos courtesy of California Energy Commission - http://www.consumerenergycenter.org/coolroof)

Energy Management Systems (EMS)

Energy Management Systems offer energy and operational savings and may include security and alarm system controls. EMS may also include a "dashboard" display of energy and operational data. EMS permits automated scheduling of HVAC and lighting, custom designed for the specific building. Display of energy management and use can be part of internal control documentation and/or made part of public informational display. EMS options may be considered that track operation of the building in forms useful for research by the Construction Management faculty and students. The design of EMS controls is normally provided by the equipment supplier and should be included in integrated design team discussions.

Innovations in HVAC Systems Design
Alongside natural lighting, HVAC components may represent the greatest opportunity for energy conservation and lower cost operation over the life of the building. Recent innovations in design and construction have resulted when all of the building subdisciplines are integrated into collaborative solutions. The goals of collaborative design of architectural and engineering components can be summarized as six guidelines:

- Lower load by peak demand reduction, zoning and smart controls.
- Optimize the design insulation and mechanical requirements based on energy modeling.
- Use “Victorian Engineering” to design natural lighting and ventilation.
- Use passive sources of sunlighting, sun-tempering, thermal mass cooling, and ventilation.
- Right size equipment for the task, with modular sizing to reduce pipe and duct runs.
- Use smart controls that can be easily adjusted by building managers.

Given that an investment in the construction of a building is from 50 to 100 years, any design and engineering should anticipate future adaptability and changes of zone uses within a building, as well as additions (where the site permits). These options may lead to interior space and HVAC/lighting systems that are “modular” and easily added to without replacement of the central plant. Future expansion or internal remodeling is also aided by detailing of interiors for easy change (without disrupting ongoing operations).

The HVAC field is experiencing rapid innovation as new technologies are developed to respond to both energy and environmental costs. The following items represent innovative approaches to HVAC design and installation for energy efficiency and lower cost construction and operation. They are suggested here as a “schematic design checklist,” listed by “order of magnitude” potential for energy reduction. A full description of each technology is provided in Reference 7.

- Radiant ceiling cooling/chilled beam
- Enthalpy/energy recovery heat exchangers for ventilation
- Dedicated outside air systems
- System component diagnostics
- Adaptive/fuzzy logic controls
- Improved duct sealing
- Variable refrigerant volume flow
- Liquid desiccant air conditioners
- Novel cool storage
- Displacement ventilation
- Electronically commutated permanent magnet motors
- Heat pumps for cold climates (zero-degree heat pump)
- Microenvironmental occupancy-based controls
- Micronic channel heat exchanger

- Smaller centrifugal compressors
- Alternate sources of cooling
- Cool towers
- Lower pressure drop by streamlined plumbing
- Lower fan energy through slightly larger ducting.
- Natural ventilation with mixed mode "economizer cycle"
- Thermal mass and night purging

Green Materials
"Green materials and products" refers to a broad range of new construction materials, methods and products that are being introduced in the market for improved air quality, lower environmental impact or other benefit. Improved indoor air quality is important to individuals prone to allergies and chemical sensitivity and in many studies is correlated with higher productivity and lower absenteeism at work. Another benefit is the showcasing of materials and processes that have less environmental impact and are of interest to businesses and industries developing green materials and products.

Many standard products are now being upgraded to include green features, such as gypsum wallboard with recycled content and "green" paints with low or no volatile organic compound (VOC) content.

Interior finishes and furnishings are now available from recycled materials, including rubber flooring, sheet linoleum, recycled content counters, low and no formaldehyde cabinets and furniture, carpeting that carries "cradle-to-cradle" certification, etc. A design approach, which reduces construction cost, is to reduce or eliminate interior detailing (e.g., plastics and oil-based products) that normally cover structural and mechanical equipment, using instead an aesthetic of exposed walls and ceilings typical of "bare bones" remodeling and adaptive reuse.

Green Infrastructure
Green infrastructure includes landscape planting and rain gardens (e.g., absorptive, water-collecting plants) and—subject to architectural design—the addition of trellises for green wall screens. Also included are porous paving and/or garden and treed areas that retain and absorb stormwater runoff. (See EPA Green Infrastructure Initiative, http://cfpub.epa.gov/npdes/greeninfrastructure.cfm)

In addition to the amenity of landscape, green infrastructure can reduce the cooling load on buildings (by shading) and increase the outdoor comfort in public areas (such as terraces) by shading and evaporative cooling. Greenscaped parking lots can reduce measured ambient outdoor temperature (at the paved surface) from 150°F to 90°F, and even more with evaporative cooling. Greenscapes can lower project costs by reducing stormwater management infrastructure requirements.

Porous Pavement
Porous pavement allows rainwater to seep through the surface to a subsurface layer, where it may be absorbed into the ground or stored. This increases groundwater recharge, reduces pollutants in stormwater runoff and helps to alleviate flooding and contamination to streams.

Porous pavement is a permeable pavement surface with a stone reservoir underneath. The reservoir temporarily stores surface runoff before infiltrating into the subsoil. Porous pavement often appears as the same as traditional asphalt or concrete but is manufactured without "fine" materials and instead incorporates void spaces that allow for infiltration; it is ideal for low traffic, parking areas and walkways. In extremely dense urban areas, porous pavement has been used in redevelopment projects where it treats and stores stormwater without consuming extra land. Porous pavement can also be used on individual sites where a parking lot is being resurfaced. (See http://www.epa.gov/OWM/mtb/porouspa.pdf)

Costs for porous asphalt are approximately 10% to 15% higher than those for regular asphalt. Limiting paving areas only to trafficked lanes and leaving parking spaces as gravel can reduce costs. The higher cost of installation of porous pavement can be offset to some extent by the elimination of curbs, gutters and storm drains. In some cases this may lower the overall cost for a project. The final economics associated with a particular site are also affected by site-specific conditions, such *in situ* permeability and the cost and proximity of gravel supplies. (See "fact sheets" at The Stormwater Manager's Resource Center, http://www.stormwatercenter.net)

Dr. Strong noted that many of the MSU civil engineering alumni would be interested in testing a porous pavement system.

Structural Soil Cells

Structural soil cells are modular interlocking plastic cells placed around landscaped tree roots. The cells prevent compaction of the soil, leaving spaces for water and tree roots. Originally developed by Dr. James Urban, landscape architect, the system provides stormwater retention, using trees for their water holding capacity, while also shading and cooling parking areas. The cells provide support for paving and contain soil and loose aggregate to store water for urban tree root systems. They permit closer spacing of trees and less soil while also directing stormwater to tree roots. The system allows a parking area to be a treed "urban oasis." (See http://www.toronto.ca/environment/pdf/james_urban and http://www.deeproot.com/pdfs/PNW_Trees_article.pdf)

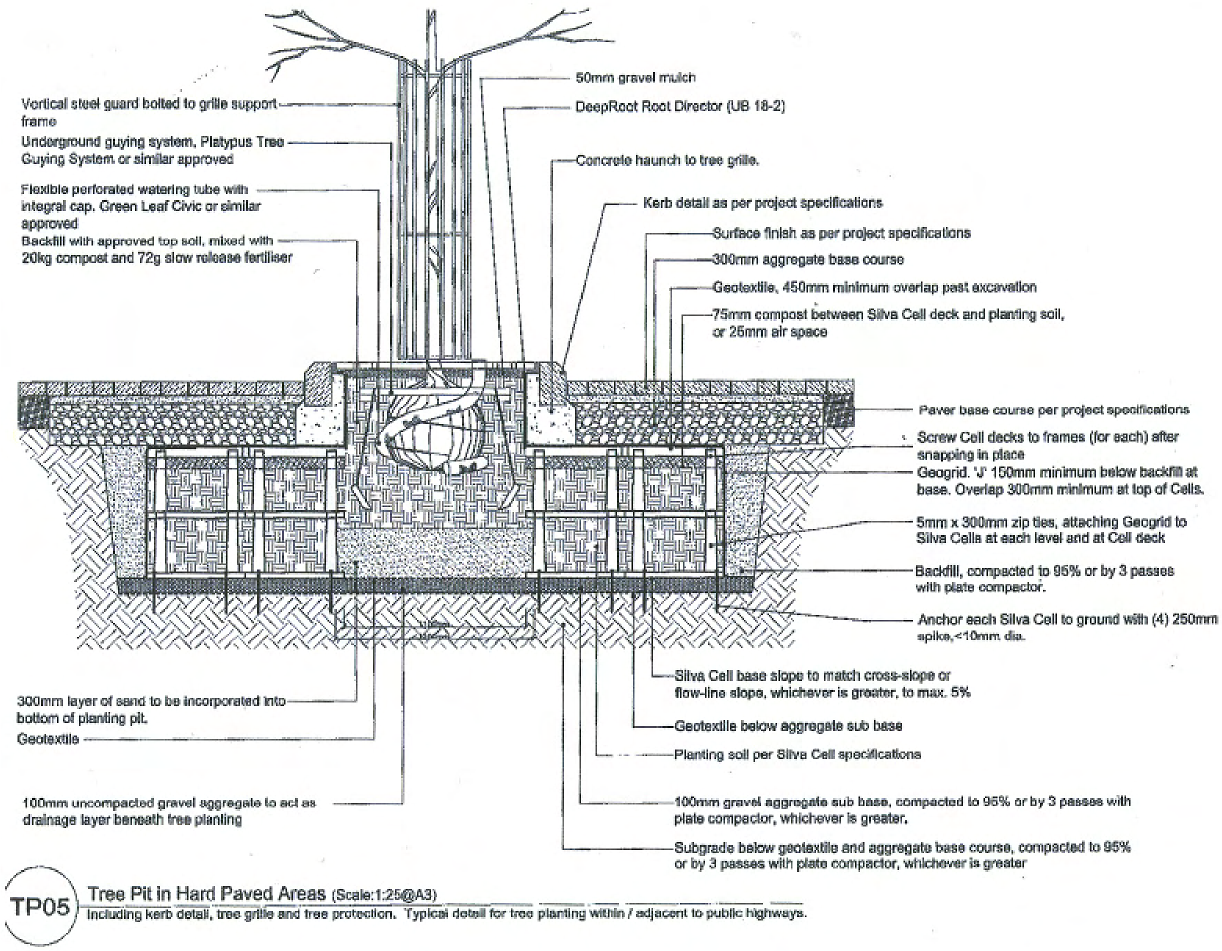

Figure 4: Tree Cell Construction Detail

Missouri State University Campus Overview

Innovation, Design, Entrepreneurship, and Arts (IDEA) Commons

IDEA Commons is an initiative by MSU and the City of Springfield to create a vibrant urban community and research park in an urban setting that blends residential, retail, commercial, and entertainment areas. IDEA is an acronym that stands for "Innovation, Design, Entrepreneurship, and Arts." The initiative features parts of the University that have a common creativeness and potential for commercialization (Ref. 2).

Entrepreneurship and Business Development Center Project Overview

The EBDC project involves renovation and adaptive reuse of the former 120,000-square foot Willow Brook Foods processing facility. EBDC is a key element of the University's and community's vision and plan for IDEA Commons. The master plan envisions a unique urban research park that will bring together the elements of innovation, design, entrepreneurship and arts. The vision is to create an area that is attractive for young talent to live, work and play (Ref. 3).

The University acquired five properties from the City of Springfield to help carry out this vision. In addition, the University is acquiring the former Willow Brook Foods processing plant for this project. The facility will be the primary location carrying out the entrepreneurship component of IDEA Commons.

The facility will include the Small Business and Technology Development Center, MSU's Technology and Construction Management Department, and community partners, such as the Small Business Administration and Missouri Enterprise. This academic department is a strong fit with this facility based on the type of instruction and involvement that students have in the business community. The lab space can also be used as incubator support space, permitting prototyping and modeling as part of faculty and student research and practicum opportunities.

The preliminary cost estimate for Phase I is $7 million, of which $4 million are construction costs. The project budget for the entire facility (both phases) is estimated at $11 million. Phase II funds have not been committed at this time.

Summary of Workshop
Workshop Agenda

Wednesday, December 2, 2009

8:30am	1 – Introduction to the project
9:00am	2 – Concepts and potential of the site and building
10:45am	3 – Green approaches to site, parking, connections to campus and city
1:00pm	4 – Green approaches to building
2:30pm	5 – Preliminary LEED assessment and next step assignments
3:30pm	6 – Showtime: Overview and review comments by invited guests

Workshop Participants
Allen Kunkel, MSU, Associate VP Economic Development
Doug Sampson, MSU, Architect/Director, Campus Planning
David Vaughan, MSU, Director, Environmental Management
Bret Steele, MSU, Energy Coordinator
Dr. Shawn Strong, MSU, Professor and Head of Construction Management Department
Terry Rowland, MSU, Project Manager/Architect
Olivia Hough, City of Springfield, Senior Planner/Brownfield Coordinator
Todd Wagner, City of Springfield, Stormwater Engineer
Ashley Crites, City of Springfield, Intern
Joe Vejraska, AIA, Gaskin Hill Norcross, Project Architect
Jennifer Winslow, Gaskin Hill Norcross, Mechanical Engineer
Anna Kangas, LEED AP, Gaskin Hill Norcross
Alma Moreno-Lahm, EPA Region 7, Brownfields Project Manager

Camron Adibi, LEED AP, Sustainable Designer, Vita Nuova LLC
Donald Watson, FAIA, NCARB, Architect and Planner, Vita Nuova LLC

Showtime Attendees
Rayanna Anderson, Small Business & Technology Development Center, Assistant Director
James Baker, MSU, VP Research and Economic Development
Jeff Brown, MSU, Sustainability Coordinator
Greg Burris, City of Springfield, City Manager
Bob Eckels, MSU, Director, Facilities Management
Mary Lilly Smith, City of Springfield, Director, Economic Development
Ken McClure, MSU, VP Administrative and Information Services
Matthew Schaeffer
Collin Quigle, City of Springfield, Assistant City Manager
Ralph Rognstadt, City of Springfield, Director, Planning and Development

MSU Construction Management Department Faculty
Richard J. Gebken, Assistant Professor of Technology and Construction Management
David Joswick
Kerry T. Slattery, Ph.D.
Dianne K. Slattery, Ph.D.

Summary of Workshop Discussion
Goals and aspirations for the project as expressed by the attendees:
- Be a "standout" in the community
- Develop more LEED projects on MSU campus
- Model for other Springfield projects
- "Building as a teaching tool" – demonstrate educational components
- Use as many sustainable features with the available funding
- Make the building functional for its many purposes
- Lower operational and maintenance expenses
- Create an "anchor for the region" – training center for construction management professionals; entrepreneurial center for new businesses
- Address floodplain design requirements opportunities (landscape and parking areas)
- Building itself permit "seed-bedding" of construction related innovations

Concepts and Potential of the Site and Building
Architectural assets of the existing building:
- Durability, built over Jordan Valley Creek (strong footings)
- Large interior and exterior space (good for the Construction Management Department)
- Established and relatively new electrical system

Limitations
- Economic Development Agency (EDA) grant limits maximum allowable academic space to 25% of total interior for Phase I
- Phase II is intended for the new location for the Construction Management Department
- Exterior Insulation and Finish System (EIFS) construction not used on MSU campus due to poor performance record and image
- Existing columns could restrict layout

- Vertical circulation (stairways do not meet current code)
- Tenants, as the case with Jordan Valley Innovation Center (JVIC), may want to expand in the future
- Tenants will be on sub-meters and will be responsible for fit-out of the areas they lease
- MSU has approved more outdoor lighting due to safety concerns
- Building is in the 100-year floodplain (parking lot floods frequently, more than 4 feet)
- The property will be re-zoned from light manufacturing to “University”

Sustainable Design and Related Design Opportunities

- The building material, conduit, metal, and partitions could be reused or recycled (Contractor needs to have a recycling plan, which can be required as part of “General Conditions” of the contract for construction).
- The double height spaces in the interior offer opportunities for daylighting, especially in large loft work areas.
- Determine the size of an auditorium and possible location.
- Plan for 100-year uses (allowing for tenant flexibility is key).
- Wayfinding and clarity of circulation can be accomplished by daylighting and views.
- Consider natural ventilation for cooling; consider no AC for large spaces in Phase II.
- The Construction Management Department would like to install a Computer Automatic Virtual Environment (CAVE) for instruction in the future. This is essentially a “theater” space and would have special requirements for electrical and cooling.
- Investigate ways to minimize watt/square foot. In general, building code maximizes lighting for the entire floor plate and does not consider reductions possible with task lighting.
- The city uses the International Building Code. MSU is not required to follow the city building code but usually has a city consultative review.
- MSU is planning to have enhanced commissioning with the two new LEED buildings, the Recreational Center and the Agriculture Center.

Mechanical, Electrical and Plumbing (MEP) Considerations

- Currently all electric for heating/cooling needs. Current electric utilities are $0.04/kwh and current water rates are $3.00/1000 gallons.
- Compare decentralized to centralized systems. Decentralized HVAC systems have some possible advantages.
- Decentralized HVAC systems may provide for more energy savings opportunities.
- Visible mechanical systems important to students learning about system.
- Consider innovative HVAC technologies, such as chilled beams.
- Underfloor air systems have advantages for electrical and HVAC options and may be considered for upper floor office areas. They are not advisable on the first floor due to proximity of the 100-year Base Flood Elevation (BFE)—estimated to be at the first floor level—which would require that all electrical outlets be raised above that elevation. Precaution requires that the BFE be considered as “minimum.” Design provisions may lead to a greater margin of safety based on engineering analysis of flood elevation data and local floodplain record of flooding trends.
- Maximum zones for tenant spaces would be 1,000 square feet, each with a sub-meter.

- Ground source heat pumps should be investigated.
- Discussion of evaporative cooling towers; possible use of silos and or new towers worth investigating.
- Building integrated wind power is a possibility (being used for the new LEED building for MSU).
- Low-water fixtures/toilets are specified for all MSU facilities. The city has incentives to reduce water use volume. Sewer charges are based on volume of water use.

Briefing with Todd Wagner: Green Approaches to Site, Parking, Campus, and City
Todd Wagner, City of Springfield Stormwater Engineer presented current issues related to flooding:

1. Federal Emergency Management Agency (FEMA) updated the 1960 flood maps in 1990 and increased the BFE. City conducted its own study to determine its own data for BFE. In 2000, the city mapped where Jordan Creek is and is now in the process of daylighting the creek.
2. FEMA is reviewing the city BFEs and is expected to have final maps approved in six to 12 months. In 2000, flood elevations were within six inches of the city's BFEs. The floor of the existing building at Willow Brook is at the current 100-year BFE (1% probability of annual occurrence).
3. The U.S. Army Corps of Engineers is in the process of a 500-year flood elevation determination (.02% probability of annual occurrence) (Refs. 5 and 6).
4. EPA's Municipal Separate Storm Sewer Systems (MS4) permit is now in effect. Water quality treatment and volume reduction is required for all new development projects.
5. Low impact development (LID) and porous pavement are good measures for first flush retention and absorption of stormwater. When properly designed, they can reduce stormwater runoff by 20% to 50% when the ground is not frozen.
6. Stormwater with heavy sediment can easily clog some porous pavement systems, such as poured aerated concrete, which relies upon air voids to allow water to filter through it to a gravel base below. In general, these systems perform well, but need to be cleaned every six to 12 months.
7. Springfield has experience with and monitored case studies of porous pavement. The Green Circle project is working well and provides a good example. Several other pilot projects in the Springfield area use porous pavement, from which practical lessons learned are being documented.

<u>Flooding concerns</u>
Flooding concerns are summarized in an ongoing study by the U.S. Army Corps of Engineering (Ref. 6):

> *"Jordan Creek has flooded many times. During the flood of July 2000, there were an estimated $1.85 million in flood damages including the interruption of traffic on main city thoroughfares and rail lines. The existing channels and covered conduits are inadequate to carry a flow that has increased with the growing development in the Jordan Creek watershed. Flood control measures to be considered include structure relocations, detention ponds, open channels, and in congested areas, enlarging underground culverts.*

> *Likewise, development along Jordan Creek has decreased riparian habitat and water quality. Opportunities exist to restore ecosystem habitat and improve water quality by measures such as constructed wetlands, water quality sediment basins, and riparian enlargement."*

Given these identified concerns, the potential for Jordan Creek to flood will be a significant factor in design, construction and risk management of the entire IDEA Commons site and its facilities. All site and building utilities normally located below grade have to be flood-proofed, with flood-resistant construction measures to be certified during construction.

Flooding of parking and landscape surfaces can be expected as a frequent and recurring event at any time of year, including late winter or early spring when ground surfaces are frozen and unable to absorb even the first flush of inundation. With so much area within the area built up as hardscape, even when the ground is not frozen, flash flooding is typically evidenced by a very rapid rise of water. As in any floodplain with these characteristics, sewers and roadways are quickly flooded to the point of making emergency egress and access impossible with normal vehicles. Cars that are parked in such areas may become damaged and inoperable with flood levels of 14 to 18 inches. The risk of such flooding occurring rapidly will require special controls on access to onsite parking.

Developing landscape areas to retain the first flush of stormwater runoff—using measures such as porous paving, treescapes, bioswales, and rain gardens—is helpful by slowing the rate of flood rise and thus allowing more time for orderly emergency egress. In cases where the ground is frozen, flood control measures must rely on channels and floodways to reduce and mitigate the extent of inundation.

The channel improvements and greenway development of the Jordan Creek "daylighting" project provides the framework for area-wide remediation (See Figure 5: Jordan Creek Daylighting and Greenway Project). Such floodplain management measures must be extended to all properties, which are otherwise part of the problem. As a model for the area and city, MSU should extend the daylighting and greenway project into the IDEA Commons Master Plan and the EBDC site.

Figure 5: Jordan Creek Daylighting and Greenway Project

(Photo courtesy of the City of Springfield Public Works and Ozark Greenway)

Related considerations

- The shuttle stops next to the Art and Design Building. Consider opportunity for bus stop to service the Entrepreneurship and Business Development Center.
- In the new JVIC building, chemical wastes are contained in separate containers. The city monitors nutrients and conducts a chemical analysis periodically. There is no separation from laboratory drains and bathroom/kitchen drains. Reducing water volume for the IDEA Commons should be the first consideration. Then, determine the need for separating drains not being used for bathrooms and kitchens. This could reduce the number of city permits/monitoring frequency.
- MSU established a campus recycling program. Determine the location of the recycling room and bin locations in new building, as well as how it ties in with the campus recycling program.
- Design challenge to be considered: the reuse of the existing silos adjacent to the building. These are suspect structurally (approximately 6 inches of concrete at the base). The Construction Management Department could hold a design competition for possible reuse ideas/innovation.

Related programs and potential partners

- The **Partnership for Sustainability** is a new nonprofit organization of 13 partners who are committed to collaborating with each other and with the community to make sure we are being good stewards of our resources, including our natural resources. (See http://communication.missouristate.edu/Sustainability_Project.htm)

- The **Ozarks Regional Economic Partnership** is a program of the Springfield Area Chamber of Commerce in association with partner members throughout the Ozarks region. The Ozarks Regional Economic Partnership is a voluntary organization comprised of cities, counties and chambers of commerce representing local community and business leaders from a ten-county area. (See http://www.ozarkspartnership.com/)

Showtime: Overview and Review Comments by Invited Guests
Following a summary of the day's discussion, the entire group, including invited guests, proposed recommendations to emphasize in the stated goals of the project.

- *Building scale:* Flexibility of interior arrangements over long-term energy efficiency, demonstration of sustainable features with available funding, leave options for the future, and consider seed bedding building innovations.
- *HVAC:* HVAC deserves special focus, as major cost element, but opportunity for innovation, using smart controls and internal zoning. Controls and monitoring can be tied into an energy dashboard display in lobby or exhibit area. Consider district cooling. Explore use of silos as cooling towers.
- *Site scale opportunities:* Stormwater retention, opportunity for rain gardens/green parking.
- *City scale:* Tie in with city daylighting of river, greenways and new businesses in area.
- *LEED certification*: Silver is an easily achieved benchmark for new construction. "Go for Gold" to show distinction of academic, business and facilities collaboration.
- *Innovation:* Process of design and construction can follow "planning for innovation" strategies, in which multidisciplinary brainstorming occurs and alternates are considered during design in order to identify opportunities for quality improvement and cost control at each phase of the project.

Additional comments and recommendations:

- Create a microcosm of activity, an active building and focus of community of interest.
- Consider students' needs and input.
- Create a destination for students, a gathering place or outdoor campus areas (green).
- Insure accessibility both interior and exterior (safety).
- Create an active commercial and retail area in the surrounding area (restaurants).
- Promote the theme of innovation in the building and site design.
- Make the building design and construction process transparent so that faculty and students can follow it.
- Use innovative techniques of design and construction, such as skylights, energy dashboard, etc.
- Create student/faculty/business demonstrations in the exhibit hall as publicly accessible space.

Preliminary LEED Assessment and Analysis

- The new LEED system has three major changes from prior requirements: 110-point system; credit weightings (35% of credits towards energy and carbon reduction); 6 possible regional credits (4 total points).
- It is advisable to follow the LEED principles in order to have a LEED "certifiable" building (if certifying at a later date).
- Consider end users first when evaluating design options and LEED points second.
- **Appendix A** is a preliminary checklist following the U.S. Green Building Council Rating System. The final page indicates that 53 points are achievable and that an additional 17 points can be achieved, subject to further design analysis.

Achieving 53 points would gain a Silver rating. This should be considered a practical minimum. By attention to additional design and construction features, the project could qualify for some, if not all, of the additional points indicated as "questions." This indicates that the Gold rating is achievable and given the stated intention of the EBDC, should be to be a goal to establish a standard of excellence to help brand the program. This rating would distinguish the project for design and construction innovation.[1]

Because the Willow Brook site is already developed, it does not fall under this requirement. However, the floodplain issues of the site and its surrounding properties are important, suggesting that the entire Willow Brook site be designed with flood mitigation measures and flood emergency provisions fully addressed and in place.

Benefits of Energy Modeling

Energy Modeling Comparison of Base and Low-energy Cases

Energy modeling of buildings is often misunderstood as the measurement of actual energy performance. In truth, energy modeling is the practice of evaluating the energy use of a building through simulating and accounting for the many energy related components. Energy modeling has two primary functions: to test the performance of a building's design and to compare design options to find optimal energy savings. Energy modeling is most useful to gain feedback during conceptual design as well as to provide analysis during design development. Mistakenly, energy modeling is used much later in the design process.

Energy modeling or simulation is a key component in the design process. There are numerous energy strategies to consider when trying to improve energy performance in a building. First and foremost, the site location has the greatest impact. Climate data, orientation and shading from adjacent buildings are just a few of the criteria when evaluating the site. Energy simulation quickly demonstrates the energy performance qualifications from the different design choices selected.

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[1] The LEED Rating System disqualifies certain sites with the intent to avoid the development of inappropriate sites and to reduce the environmental impact of locating buildings on environmentally sensitive sites, including floodplains. The LEED Reference Guide states as a "Requirement" (i.e., a prerequisite for LEED Rating): "Do not develop buildings, hardscape, roads or parking areas on portions of sites that meet any of the following criteria: Previously undeveloped land whose elevation is lower than 5 feet above the elevation of the 100-year flood as defined by the Federal Emergency Management Agency (FEMA)."

To assist the IDEA Commons design team, non-representative energy simulations were performed using the software, Energy-10, Version 1.7.15. These energy simulations do not represent the existing building or any potential new designs located on the Willow Brook property. These comparisons are only intended as a demonstration to assist the design team in the benefits of energy modeling.

Using Energy-10 software, it was found that there was a 39% total annual energy savings for a 100,000-square foot office building in Springfield when comparing a building with "typical construction" and a low-energy design case (see Figure 6: Annual Energy Comparison between "Typical Construction" and Low-Energy Cases). The low energy design case had numerous energy efficient strategies that included: improved insulation in the walls, floor and roof; window shading; added windows to the south façade; improved glazing; improved controls/setbacks for HVAC systems; the use of economizers; reduction in duct losses; added mass; and added daylighting (see Table 1).

The total life cycle costs calculated for the low-energy design case were less than the typical construction design case (approximately 5% less). Although the initial capital costs were more for the low-energy design case, the utilities, maintenance and the HVAC replacement costs were considerable less when compared to the typical construction design case (see Figure 7: Life Cycle Cost Comparison between "Typical Construction" and Low-Energy Cases).

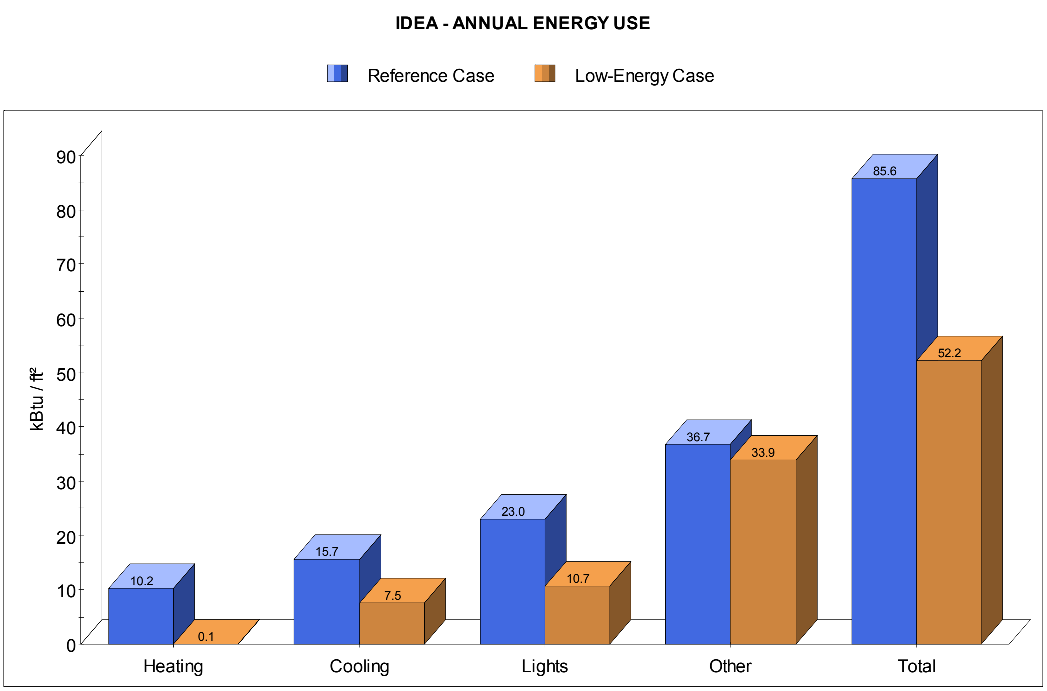

Figure 6: Annual Energy Comparison between "Typical Construction" and Low-Energy Cases

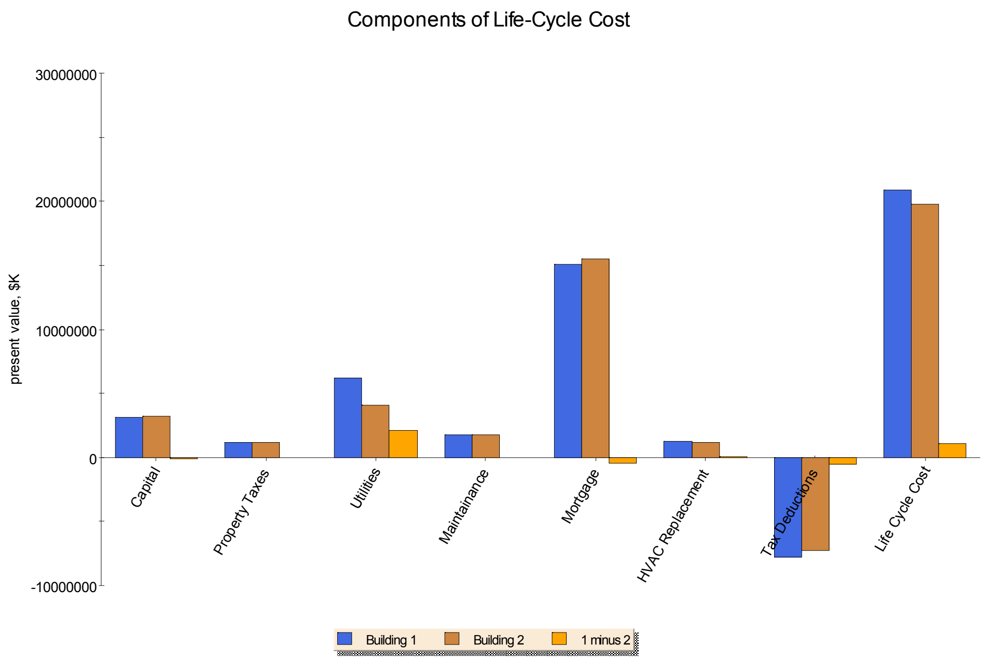

Figure 7: Life Cycle Cost Comparison between "Typical Construction" and Low-Energy Cases

The Energy-10 software allows one to ascertain the effects of several strategies and "rank" them with a Net Present Value (NPV). NPV is an economic figure of merit for evaluating an investment. It quantifies the benefit in terms of equivalent dollars in the first year of the building life. It does this by discounting future cash flows to the present time using a specified discount rate.

The three highest rankings of the low-energy design strategies were energy efficient lights, minimizing duct leakages and improving insulation. These are attainable design choices for the IDEA Commons project. Daylighting had a low ranking, but it should be noted that the energy simulations did not factor the wide footprint of the building nor the existing opportunity with the double height spaces in the interior. Also daylighting studies have shown improved occupant satisfaction and improved performance of occupants. The energy rankings do not consider these factors.

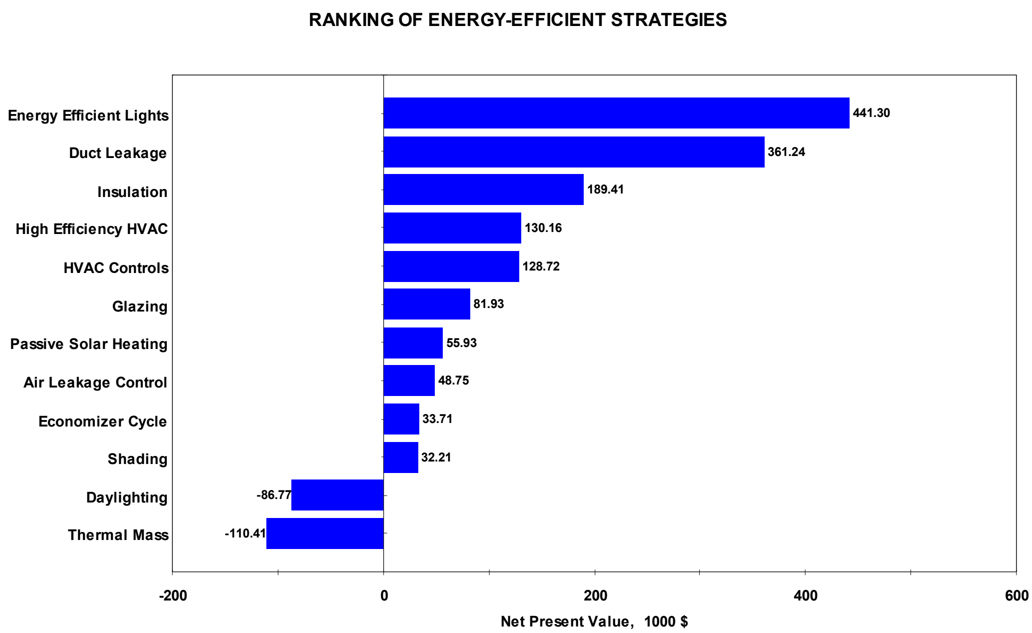

Figure 8: Ranking of Energy-Efficient Strategies with Net Present Values

Description:	"Typical Construction" Case	Low-Energy Case
Simulation status, Thermal/Daylight	valid/NA	valid/valid
Weather file:	Springmo.et1	Springmo.et1
Floor Area, ft²	100000	100000
Surface Area, ft²	216782.9	216782.9
Volume, ft³	1300000	1300000
Total Conduction UA, Btu/h-F	10841.6	6030
Average U-value, Btu/hr-ft²-F	0.05	0.028
Wall Construction	steelstud 4, R=8.1	steelstud 6 poly, R=19.2
Roof Construction	flat, r-19, R=19.0	flat r-38, R=38.0
Floor type, insulation	Slab on Grade, Reff=86.1	Slab on Grade, Reff=387.3
Window Construction	4060 double, alum, U=0.70	4060 low-e al/b, U=0.31
Window Shading	None	40 deg latitude
Wall total gross area, ft²	16783	16783
Roof total gross area, ft²	100000	100000
Ground total gross area, ft²	100000	100000
Window total gross area, ft²	3984	8208
Windows (N/E/S/W:Roof)	50/33/50/33:0	28/12/95/9:198
Glazing name	double, U=0.49	double low-e, U=0.26
Operating parameters for zone 1		
HVAC system	DX Cooling with Gas Furnace	DX Cooling with Gas Furnace
Rated Output (Heat/SCool/TCool),kBtu/h	2980/2934/3912	1619/2301/3068
Rated Air Flow/MOOA,cfm	110677/15000	89380/15000
Heating thermostat	72.0 °F, no setback	72.0 °F, setback to 67.0 °F
Cooling thermostat	76.0 °F, no setup	76.0 °F, setup to 81.0 °F
Heat/cool performance	eff=80,EER=8.9	eff=90,EER=13.0
Economizer?/type	no/NA	yes/fixed dry bulb, 60.0 °F
Duct leaks/conduction losses, total %	10-Nov	2/0
Peak Gains; IL,EL,HW,OT; W/ft²	1.78/0.33/0.26/1.52	1.33/0.25/0.26/1.52
Added mass?	none	50000 ft², 8in cmu
Daylighting?	no	yes, continuous dimming
Infiltration, in²	ELA=2232.1	ELA=604.2
Results:		
Energy cost	0.400$/Therm,0.054$/kWh,2.470$/kW	0.400$/Therm,0.054$/kWh,2.470$/kW
Simulation dates	01-Jan to 31-Dec	01-Jan to 31-Dec
Energy use, kBtu	8563940	5223805
Energy cost, $	136052	89031
Saved by daylighting, kWh	-	193023
Total Electric, kWh	2092229	1410047

Internal/External lights, kWh	540533/134904	212547/101178
Heating/Cooling/Fan, kWh	0/459050/152538	0/220377/70741
Hot water/Other, kWh	0/805205	0/805205
Peak Electric, kW	733.6	465.6
Fuel, hw/heat/total, kBtu	404820/1019807/1424626	404820/7481/412301
Emissions, CO2/SO2/NOx, lbs	2980204/16685/8763	1943796/11185/5835
Construction Costs	15949669	16435710
Life-Cycle Cost	20835479	19781394

Table 1: Summary of "Typical Construction" and Low- Energy Cases

Energy Modeling Comparison of Different Values for Roof Insulation

From the rankings mentioned in the previous section, improved insulation is a good choice when considering the different energy efficient strategies. To optimize insulation values, it is best to consider both the costs of applying the strategy and the costs of the HVAC changes that are implied. It is also essential in making discrete choices with the insulation types to find the values that are most cost effective. It is not advisable, however, to consider the insulation values of the roof insulation without first optimizing the entire design and all the different wall insulation options.

However, during the IDEA Commons workshop, it was stated that the existing roof will need to be replaced within four to six months. Due to this urgency, energy simulations using Energy-10 software were performed to compare different values for roof insulation only. A typical construction design case was used as the base case. This roof had an R-value of 19 with 2.7 inches of polyiso foam. The two low-energy design cases had roof insulation values of R-38 and R-55. The R-38 roof had 10.8 inches of fiberglass, while the R-55 roof had 10.8 inches of Expanded Polystyrene (EPS) foam.

From the results, the R-38 roof had a 6.2% reduction in the total annual energy costs when compared to the typical construction. The R-55 roof had an 8.3% reduction in the total annual energy costs when compared to the typical construction.

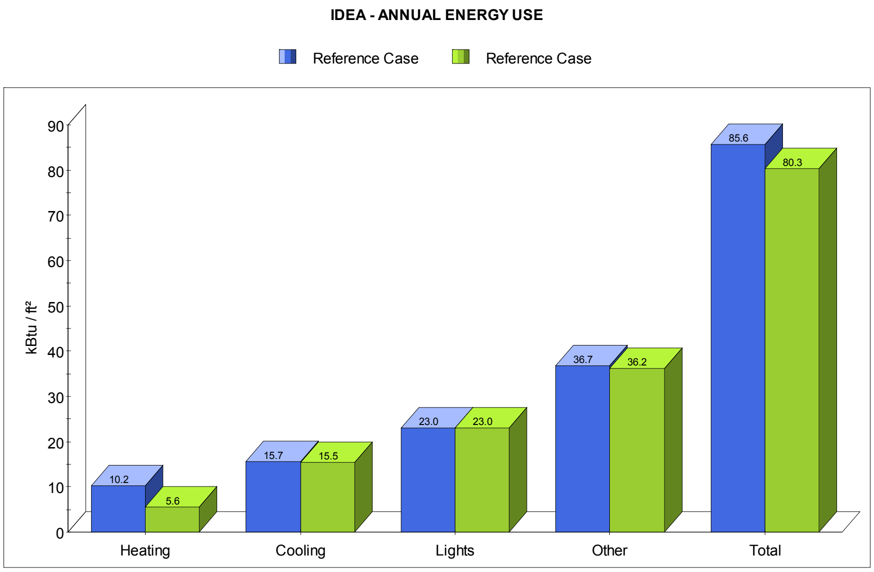

Figure 9: Annual Energy Comparison of Roofs with Different Insulation Values

(R-19 roof in blue and R-38 roof in green)

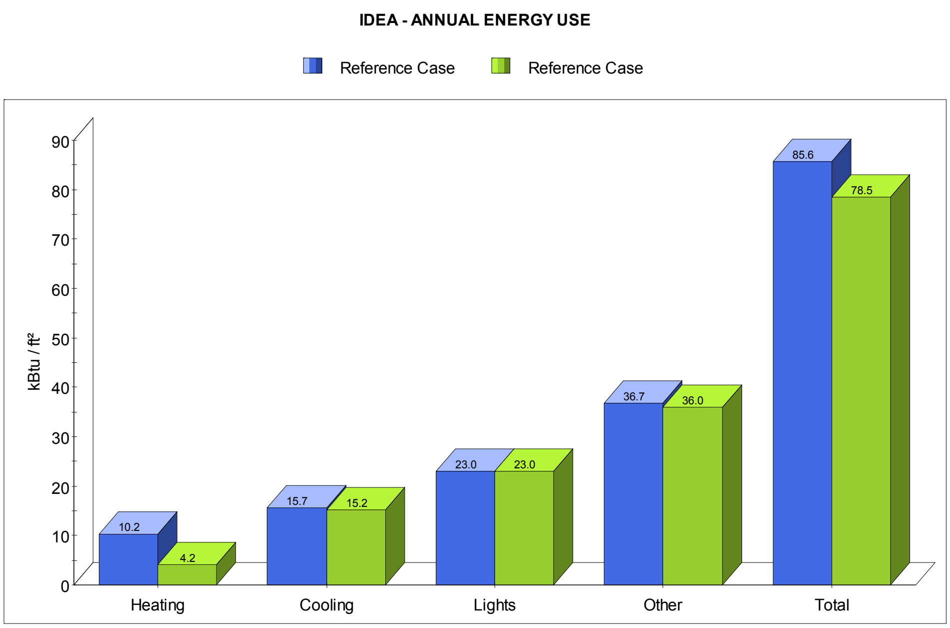

Figure 10: Annual Energy Comparison of Roofs with Different Insulation Values

(R-19 roof in blue and R-55 roof in green)

References

Ref. 1 Vita Nuova LLC, "*Report of the EPA/IDEA Commons Pilot Project Meeting,*" June 26, 2009.

Ref. 2 Missouri State University IDEA Commons, http://www.missouristate.edu/ideacommons.

Ref. 3 Missouri State University IDEA Commons, "Entrepreneurship and Business Development Center - Missouri State University Program Description - Review Checklist" (internal document).

Ref. 4 Missouri State University Office of Design and Construction, Building Project Initiations, http://www.missouristate.edu/facilities/7978.htm and Building Standards, http://design.missouristate.edu/Documents/Documents.htm.

Ref. 5 Letter from Rick Garber, P.E., Building Development Services, City of Springfield to Allen Kunkel, August 16, 2009.

Ref. 6 U.S. Army Corps of Engineers, "*Springfield Missouri Feasibility Study 2009*," http://www.swl.usace.army.mil/planning/feasibilitystudy/index.htm.

Ref. 7 Roth, Kurt W., et al., Energy Consumption Characteristics of Commercial Building HVAC Systems, Vol. III: Energy Savings Potential, U.S. Department of Energy, July 2002, pg. 285, http://doas-radiant.psu.edu/DOE_report.pdf.

Appendix A: LEED 2009 Project Checklist for New Construction and Major Renovation

LEED 2009 for New Construction and Major Renovation

Project Checklist

Project Name: IDEA Commons (Preliminary Assessment)

Date: December 2, 2009

Y	N	?		Sustainable Sites	Possible Points: 26
17	6	3			
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
5			Credit 2	Development Density and Community Connectivity	5
1			Credit 3	Brownfield Redevelopment	1
6			Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
	3		Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
2			Credit 4.4	Alternative Transportation—Parking Capacity	2
1			Credit 5.1	Site Development—Protect or Restore Habitat	1
	1		Credit 5.2	Site Development—Maximize Open Space	1
		1	Credit 6.1	Stormwater Design—Quantity Control	1
		1	Credit 6.2	Stormwater Design—Quality Control	1
	1		Credit 7.1	Heat Island Effect—Non-roof	1
		1	Credit 7.2	Heat Island Effect—Roof	1
	1		Credit 8	Light Pollution Reduction	1

Y	N	?		Water Efficiency	Possible Points: 10
2	2	6			
Y			Prereq 1	Water Use Reduction—20% Reduction	
		4	Credit 1	Water Efficient Landscaping	2 to 4
				2 — Reduce by 50%	2
				No Potable Water Use or Irrigation	4
	2		Credit 2	Innovative Wastewater Technologies	2
2		2	Credit 3	Water Use Reduction	2 to 4
				2 — Reduce by 30%	2
				Reduce by 35%	3
				Reduce by 40%	4

Y	?	N				
11	7	17	**Energy and Atmosphere**		Possible Points:	**35**
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems		
Y			Prereq 2	Minimum Energy Performance		
Y			Prereq 3	Fundamental Refrigerant Management		
7		12	Credit 1	Optimize Energy Performance		1 to 19
					Improve by 12% for New Buildings or 8% for Existing Building Renovations	1
					Improve by 14% for New Buildings or 10% for Existing Building Renovations	2
					Improve by 16% for New Buildings or 12% for Existing Building Renovations	3
					Improve by 18% for New Buildings or 14% for Existing Building Renovations	4
					Improve by 20% for New Buildings or 16% for Existing Building Renovations	5
					Improve by 22% for New Buildings or 18% for Existing Building Renovations	6
				7	Improve by 24% for New Buildings or 20% for Existing Building Renovations	7
					Improve by 26% for New Buildings or 22% for Existing Building Renovations	8
					Improve by 28% for New Buildings or 24% for Existing Building Renovations	9
					Improve by 30% for New Buildings or 26% for Existing Building Renovations	10
					Improve by 32% for New Buildings or 28% for Existing Building Renovations	11
					Improve by 34% for New Buildings or 30% for Existing Building Renovations	12
					Improve by 36% for New Buildings or 32% for Existing Building Renovations	13
					Improve by 38% for New Buildings or 34% for Existing Building Renovations	14
					Improve by 40% for New Buildings or 36% for Existing Building Renovations	15
					Improve by 42% for New Buildings or 38% for Existing Building Renovations	16
					Improve by 44% for New Buildings or 40% for Existing Building Renovations	17
					Improve by 46% for New Buildings or 42% for Existing Building Renovations	18
					Improve by 48%+ for New Buildings or 44%+ for Existing Building Renovations	19
	5	2	Credit 2	On-Site Renewable Energy		1 to 7
					1% Renewable Energy	1
					3% Renewable Energy	2
					5% Renewable Energy	3
					7% Renewable Energy	4
					9% Renewable Energy	5
					11% Renewable Energy	6
					13% Renewable Energy	7
2			Credit 3	Enhanced Commissioning		2
2			Credit 4	Enhanced Refrigerant Management		2
		3	Credit 5	Measurement and Verification		3
	2		Credit 6	Green Power		2

9	1	4	**Materials and Resources**		Possible Points: **14**
Y			Prereq 1	Storage and Collection of Recyclables	
3			Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
				Reuse 55%	1
				Reuse 75%	2
				3 Reuse 95%	3
	1		Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
2			Credit 2	Construction Waste Management	1 to 2
				50% Recycled or Salvaged	1
				2 75% Recycled or Salvaged	2
		2	Credit 3	Materials Reuse	1 to 2
				Reuse 5%	1
				Reuse 10%	2
2			Credit 4	Recycled Content	1 to 2
				10% of Content	1
				2 20% of Content	2
2			Credit 5	Regional Materials	1 to 2
				10% of Materials	1
				2 20% of Materials	2
		1	Credit 6	Rapidly Renewable Materials	1
		1	Credit 7	Certified Wood	1

9	1	5	**Indoor Environmental Quality**		Possible Points: **15**
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
		1	Credit 1	Outdoor Air Delivery Monitoring	1
1			Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
1			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
		1	Credit 6.2	Controllability of Systems—Thermal Comfort	1
		1	Credit 7.1	Thermal Comfort—Design	1
		1	Credit 7.2	Thermal Comfort—Verification	1
		1	Credit 8.1	Daylight and Views—Daylight	1
	1		Credit 8.2	Daylight and Views—Views	1

Y	?	N			Possible Points
2	0	4	**Innovation and Design Process**		Possible Points: **6**
1			Credit 1.1	Innovation in Design: Specific Title	1
		1	Credit 1.2	Innovation in Design: Specific Title	1
		1	Credit 1.3	Innovation in Design: Specific Title	1
		1	Credit 1.4	Innovation in Design: Specific Title	1
		1	Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1
3	0	1	**Regional Priority Credits**		Possible Points: **4**
1			Credit 1.1	Regional Priority: SS Credit 1	1
1			Credit 1.2	Regional Priority: SS Credit 5.1	1
1			Credit 1.3	Regional Priority: MR Credit 5	1
		1	Credit 1.4	Regional Priority: SS Credit 6.2	1
53	17	40	**Total**		Possible Points: **110**

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110